A COURSE IN FORM STUDY

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It is commonly assumed that recognition of the form and position of objects will develop in children without special instruction on the part of the teacher. No place has been provided in the ordinary school programme for the purpose of training such types of recognition. If one refers to the spatial characteristics of objects as a subject of special study, he is likely to be referred to geometry as an advanced science and as appropriately placed late in the high school course of study. The idea that one may definitely study spatial characteristics in the early grades must be established by some argument and such argument will always encounter the inertia of tradition.

In the effort to show the unreasonableness of the present tradition, one may first review certain salient historical facts. If one considers the development of mathematical science in European history, he finds that the great emphasis was at first on geometry. If this means anything, it shows that the early Greeks, who developed the science long before they had any definite notions of algebra or many of the higher forms of mathematics, were dealing with a problem that naturally suggested itself to those who were beginning the study of the world about them. The early Greeks worked out a kind of experimental geometry. They learned the properties of angles and of the various plane figures by actual contact with these figures and through the effort to fit them to each other. In this way they developed a body of geometrical knowledge which was very complete. It was mature because it had been long studied. At this point came the historical event which made the study of space appear to be a very complicated and advanced form of knowledge. Euclid at the University of Alexandria was acquainted not only with geometry, but also with the forms of

Aristotelian logic, a highly organized system of formal reasoning. Euclid used his twofold knowledge to work out a type of logical geometry which has been the subject utilized in European and American institutions of learning ever since the Alexandrian period.

In a way it was a great misfortune that geometry should thus be elevated to the position of an advanced subject. Later educators made the mistake of assuming that its highly logical form was due to the inherent complexity of the subject itself and they made no effort to take up the study of space in lower schools because of this apparent complexity of the science. Geometry, however, is not necessarily connected with the logical form in which we ordinarily think of it. Instead of defining a triangle in a strictly logical or syllogistic way as Euclid did, it is quite possible to become acquainted with the general characteristics of this figure in a practical way as the Greeks had done long before the time of Euclid. Indeed, it cannot be too vigorously pointed out that geometry was one of the first and most primitive sciences.

What has been the result of substituting the Euclidian type of geometry for the natural type? Most people go through life with no ability to deal with form and distance. The only angle which is recognized with any degree of precision by the ordinary individual is the right angle in which the lines are vertical and horizontal. Even this very simple angle is not clearly recognized if it is placed in such a position that its sides are oblique. When it comes to the more complicated shapes, the ordinary observer not only has no training in the recognition of these forms, but he definitely turns away from them. A person who goes about every day and pays no attention to the forms of the trees which he passes and the shapes and positions of the other objects of his environment except to avoid them, is cultivating a habit of seeing the objects of his environment only to the extent necessary to escape contact with them. Such a habit of neglecting objects is none the less a definite habit because it is negative in its results. The habit of neglecting the form of objects is often furthered by a subtle training received in learning to read in such

a way as to avoid detailed observation of words. We often train children to see only the outlined characteristics of the words at which they glance. They are thus trained to read rapidly, but are unable to spell.

There is still another tendency of elementary education which contributes to the neglect of form. Whenever there is any reference in this earliest school course to spatial matters, that reference is in terms of abstract tables in which the various metric units are described in words rather than through actual contact with objects. In this way we make space an abstract matter from the beginning of our work. We prepare the way for a later geometry which shall be nothing but a description of spatial characteristics and not an appreciation of them. Anyone can test this statement by asking a group of adults to define what they mean by fifteen inches or any other spatial unit. It will be found that the ordinary observer's knowledge of fifteen inches is very precise so far as its verbal description is concerned, and so far as its arithmetical relation to other spatial quantities is concerned, but very vague in concrete reference to the actual space itself. Gross errors will be found if we try to get comparative estimates from a group of individuals of the length of lines or the area of figures.

In a general way it is universally recognized that the ability to recognize form can be developed by practice. A suggestive experiment which can easily be worked out by those who are interested in the problem of mental development or the special problem of development of the power to recognize space, is to draw a series of simple lines which constitute a figure that can easily be reproduced by anyone who observes it. Cover such a figure as this with some sort of a shield and when all is in readiness expose it for a period of five seconds and after covering it up require the observer to reproduce it as best he can. After he has attempted to make a reproduction allow him to make a second observation of five seconds and make a second drawing. A series of such drawings will show in a very instructive way that the recognition of a simple figure consists in a series of analyses. The different parts of the figure will be

seen with different degrees of clearness in the successive observations until finally the whole figure is recognized. Such a series of experiments as this is to be compared with the experiences of a child who is for the first time confronted by any object. He sees its different parts at the outset in a vague general way, and it is only through some analysis of these parts that he gets a clear notion of the size and arrangement of the different portions of the figure. If there is no strong motive for carrying out the study of the figure in detail, the child will go away with only a vague general notion, and this general notion will not be adequate if at any later time he is put to a severe test in the recognition of the object.

The same general principle applies to such observations as children are called upon to make when they are taught to observe words. Here again there must be at some time in the child's experience a systematic analysis of the different parts of the word. In the absence of such analysis he may acquire a habit of looking at the word as a whole which will interfere seriously with the later requirements that he see the word with sufficient precision to reproduce it when he tries to spell it or when he tries to distinguish it from some similar word.

Up to this time the discussion has aimed to make clear the necessity for explicit attention to matters of form in the elementary schools. The question which now arises is the question of the method of giving such training. Certain general exercises can readily be suggested. The reproduction of lines of a given length and the careful comparison of different lines would furnish a good starting point for a series of form study lessons. After comparing lines, a comparison of surfaces could be taken up, beginning first of all with simple surfaces drawn on the blackboard or a sheet of paper, and leading ultimately to a comparison of surfaces of familiar objects surrounding the child. Speer's work with blocks as a means of training in the estimation of ratios showed very conclusively that children can learn to make accurate comparisons of cubical contents and this would furnish a third type of exercises to add to the exercises of estimation of length of lines and the sizes of surfaces.

These exercises in estimation of size could be followed by a study of angles. Children should be taught to recognize various angles such as an angle of 45°, of 15°, and intermediate angles. These angles should become familiar in various positions, as when one side is horizontal, when one side is oblique, and so on. Children should also learn something with regard to the addition of angles to each other so that they can easily estimate the total of two or three given angles. Following this work with plane angles, a number of exercises could be introduced in solid angles and in the rotation of figures. For example, children can very readily be taught to imagine the result of three or four successive rotations of a line through various planes of space. Let a line be rotated 10° to the right, 15° backward, 30° to the left, and 5° forward, and imagine the final position of the line when it starts from any given position.

Such estimation of spatial relations as this can readily be associated with training in the recognition and appreciation of symmetry in shape and well-balanced distribution of figures.

One may indulge at this point in a digression from the discussion of practical exercises in space perceptions to call attention to the fact that the work of drawing in the schools is relatively unproductive because it is not based on general training in the minute recognition of space relations. Most people are unable to draw because they do not see the forms of objects about them with any degree of precision. Training of the type described above will improve the attention for space relations in such a way as to lead to a closer examination of all objects, with the result that these few formal lessons in the recognition of certain typical space relations will serve as a basis for a self-education of a much more general type. Children who recognize forms readily will see more in a landscape or more in a printed word which is presented to them than will children who have no such training.

Thus far the suggestions with regard to training have dealt altogether with visual space. Undoubtedly much of our recognition of distance depends upon experiences which arise from actual muscular movements over the space recognized. That we

are in general vague in the estimation of such traversed spaces is due to the fact that we depend for the most part on vision even when the experience of traversing the space is present. When vision is cut out, as for example when one shuts his eyes, the ability to estimate distances through which one walks appears as very little developed. Children can be readily trained to recognize distances with great precision if they are given practice in closing their eyes and moving about from one fixed point to another.

Again, there is usually great weakness in localization of sounds. Our ears are not constructed as advantageously as are those of animals for the recognition of space relations through sound, but here again improvement will follow upon training. Sounds can be produced in different positions with reference to the observer's head and he will learn very soon how to utilize the sound sensations for the more definite localization of these various positions.

Tactual space can also be cultivated to a very high degree. It is a well known fact that the blind man utilizes his sense of touch to gain many of the types of information which the normal individual gathers through his sense of vision. It has been repeatedly shown by scientific experiments that the sensitivity of the blind man is no greater than that of the normal individual. That is, his skin does not respond more intensely to external stimulations. What the blind man has gained through experience is an increased ability to utilize his sensations. When he places his hand upon an object the sensations mean more to him because he has been training in the use of his hands for purposes of recognizing form and distance. All of the experiments which were described for vision can be repeated for touch and they have the advantage not merely of training the individual so that he recognizes objects which he handles with his hands, but they also serve to train in the general recognition of form, so that he will be interested in shapes and distances wherever he comes in contact with them.

Another type of form study has been suggested in the experiments above described. The rapid reproduction of space

relations seen for a very brief time is one of the very best ways of training children. The recognition of a map can be greatly facilitated by exhibiting a map for a very short time and then covering it up and asking for a drawing of the map. Such exercises as these have been described as flash reading and flash writing. What is gained in these various cases is immediate and precise recognition of form, under conditions which keep the attention of the children at a maximum intensity.

After such general exercises as these which have been described, the work may be turned directly into constructive geometry. The division of a line into parts by the projection of a line of known dimensions, the dissecting of an angle into different parts, the development of various surface relations, are all problems which can be taken up in the fourth and fifth grades. In the upper grades this can be made to take a form closely related to conventional geometry. This approach to conventional geometry will not necessitate the introduction of logical forms at the early stage of school work, but will furnish one of the very best means of introducing the children later to those forms of reasoning which can then be utilized chiefly as means of training in precision and coherency of thought; the study of geometry will not end, if thus introduced, in purely verbal descriptions of matters which the pupil learns in an abstract way. Teachers of geometry frequently find that the pupils who come to them in the advanced years of the high school are unable to solve the problems of geometry chiefly because they have no spatial imagination. Some of our recent textbooks have attempted to cure these common defects in imagination by presenting models of the figures which are to be utilized in the geometrical demonstration. What is needed as a foundation for more advanced geometrical study is form study of a very concrete type.

The concrete form study which would thus prepare the way for geometry would also serve other ends as has been pointed out in the foregoing discussions. Nature study would profit; spelling would improve, map study would become easy. Furthermore, such training would exercise an influence on the

whole life of the individual. By way of contrast with the ordinary individual untrained in the recognition of space relations, a child who had taken a course such as that described would be prepared to deal with such a problem as fitting a dress or assembling a machine. Space is the most fundamental fact of our environment. The reason we have neglected it in school work is that it is taken for granted as if it were perfectly recognized in everyone's experience. That this assumption is unwarranted, that we should study it as one of the most essential lessons of our elementary school, is the contention of this paper.